Forschungszentrum Dresden-Rossendorf,
Radiation Source ELBE

„Emittance Improvement and Photocathode studies in SRF Photoinjectors“

Motivation

The main advantage of a radio-frequency photoinjector with a superconducting cavity (SRF photoinjector) compared to conventional RF photoinjectors, is low rf power dissipation. Thus continuous wave operation and high average currents are possible. At the same time, SRF photoinjectors have the potential to produce high-brightness electron beams with similar good parameters like conventional RF photoinjectors. Up to now, few prototypes of SRF photoinjectors have been developed at FZD (Rossendorf), Peking University and BNL only. A first SRF photoinjector operating in an accelerator facility will be commissioned in spring 2007 at FZD (see below) at the ELBE superconducting linac and will then be a unique test bench for R&D studies in the accelerator community.

For the future e^-e^+ colliders (ILC, CLIC) high-brightness sources for polarized electron beams are needed. Existing DC photo injectors have the disadvantage of low accelerating field strength whereas normal-conducting RF photoinjectors do not reach the vacuum requirements for NEA photocathodes. From this point of view, the SRF photoinjector is a promising candidate.

The proposal is mainly devoted to modify and improve the existing SRF photoinjector of the ELBE accelerator at the FZD (Rossendorf). The aims are emittance improvement, development and application of alternative photocathodes, and to contribute with studies to the international e^-e^+ collider R&D.

Experience and previous work

FZD is operating the “Radiation source ELBE” user facility with a 40 MeV superconducting linac, two infrared FELs and several other beam lines. The ELBE linac is operated in CW with 1 mA average current. The accelerating modules containing TESLA cavities were developed at FZD. The FZD has outstanding experience in the development of superconducting RF photoinjectors. The worldwide first operating SRF gun prototype was put into operation at Rossendorf in 2002. Within the framework of the CARE project, a SRF photoinjector with a 3½-cell niobium cavitiy for the ELBE accelerator is under development. Commissioning will be in spring 2007. Beside the gun itself, a photocathode preparation lab was installed. The driver laser with a second channel for high bunch charge operation and a sophisticated diagnostics beamline have been developed in collaboration with MBI, BESSY and DESY.

Tasks

1. Emittance Improvement
   - 1.1. Laser pulse shaping and phase noise reduction
   - 1.2. RF cavity advancement for higher gradient operation–fabrication of a large grain Nb cavity
   - 1.3. Investigation of different emittance compensation methods - external solenoid field, cathode positioning and shaping, operation with additional TE-mode RF field
2. Test of alternative and advanced photo cathodes
   Photocathodes with higher Q.E., GaAs photocathodes for polarized electrons
3. Conceptional and experimental studies concerning the application of SRF photoinjectors for the production of polarized electrons, and for the Compton-back-scattering polarized positron generation.

Collaboration

Tasks	Topic	Collaboration
1.1	Pulse shaping	MBI Berlin (D), University Milan (I), INFN Frascati (I)
1.2	Large grain cavity	ACCEL GmbH (D), DESY Hamburg (D)
1.3	Emittance compensation	CCLRC Daresbury (UK), INFN Frascati (I)
2.	Photocathodes	INFN Milan (I), SLAC (USA)
3.	Studies	http://www-project.slac.stanford.edu/ilc/acceldev/injector/elec_sources.html

Cost estimation

	FZD Rossendorf (FC)	**Collaborators**
Man power	45 PM 150 k€	150 k€
Consumables	100 k€	100 k€
Durables	150 k€	-

Total: 650 k€